(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 145 025**
**B1**

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **25.07.90**

(51) Int. Cl.[5]: **B 41 J 3/54**

(21) Application number: **84115432.1**

(22) Date of filing: **14.12.84**

(54) **Multihead serial printer.**

(30) Priority: **14.12.83 JP 234311/83**
**14.12.83 JP 234331/83**
**04.05.84 JP 88376/84**

(43) Date of publication of application:
**19.06.85 Bulletin 85/25**

(45) Publication of the grant of the patent:
**25.07.90 Bulletin 90/30**

(84) Designated Contracting States:
**DE FR GB**

(56) References cited:
**EP-A-0 082 336**
**FR-A-2 439 675**
**US-A-3 874 492**

**IBM TECHNICAL DISCLOSURE BULLETIN, vol. 19, no. 9, Feb. 1977, pages 3335-3356**

**PATENT ABSTRACTS OF JAPAN, unexamined applications, M field, vol. 5, no. 50, April 9, 1981, page 64 M 62**

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**EP 0 145 025 B1**



Courier Press, Leamington Spa, England.

## Description

Background of the invention

The present invention relates to a multihead serial printer having a plurality of print heads arranged along a horizontal or character-spacing direction.

One known multihead printer is disclosed in Japanese Laid-Open Patent Publication No. 58—163670. The disclosed printer has a plurality of print heads and is selectively operable between a high-speed printing mode and a high-density printing mode. There is another known printer having a print head and a pen head both mounted on a single carriage, the printer being switchable between a mode in which the printer operates as a printer and another mode in which the printer operates as a plotter.

With the conventional multihead printers, the plurality of print heads are driven by a single motor, and each print head has a fixed print area. In such a multihead printer, the printing speed is higher in proportion to the number of print heads used in the case where characters to be printed along one line are uniformly dispersed fully across the line.

In actual printing operation, however, characters are printed in various quantities and areas, and in many cases characters are printed in left-hand portions of lines only. Therefore, the prior multihead printers have suffered problems in that only certain print heads are subjected to wear and a high temperature, and the print speed is not so high as compared with printers having a single print head.

Patent Abstracts of Japan, Vol. 5, No. 50 (M-62) (JP—A—565 775) discloses a multihead serial printer having a plurality of print heads arranged along the character-spacing or horizontal direction of a platen, where said print heads are mounted respectively on a plurality of movable carriages and a plurality of motors is operatively coupled with said carriages respectively, for independently moving said carriages, said motors being mounted on said carriages respectively, for enabling said carriages to be self-propelled. IBM Technical Disclosure Bulletin, Vol. 19, No. 9, Feb. 1977, pp. 3355—56 shows a similar multihead serial printer.

Summary of the invention

It is a primary object of the present invention to provide a multihead serial printer which has print heads subjected to uniform loads in various printing modes, is capable of printing characters at a high speed with a relatively small number of print heads, produces reduced vibrations and noise, and is small in size, light in weight, and suitable for use as a terminal of office automation equipment.

Another object of the present invention is to provide a multihead serial printer which is relatively small in size with an increased number of carriages, has a reduced number of guide shafts, and is capable of printing at a low speed and a high density without requiring to control the amount of feed of paper.

Still another object of the present invention is to provide a multihead serial printer having carriages movable at a high speed with a small drive source, and an ordinary print head and a pen head selectively usable for high-speed printing and high-speed plotting modes.

In accordance with the present invention, there is provided a multihead serial printer including a plurality of print heads mounted respectively on carriages, and a plurality of motors for independently moving the carriages, respectively, for enabling the print heads to effect printing operation uniformly. The carriages are independently movably supported on common guide shafts and movable in a horizontal or character-spacing direction by independent drive sources. At least one carriage has a shift mechanism for moving the print head along the surface of a platen in a paper-feeding direction. One of the print heads may comprise an ordinary print head and the other a pen head having a plurality of pens. The pen head has means for selectively pressing the pens and a vertical shift mechanism for moving the pens along the platen surface in the paper feeding direction (column direction).

Brief description of the drawings

Fig. 1 is a perspective view of a multihead serial printer according to a first embodiment of the present invention;

Fig. 2 is a fragmentary perspective view of a mechanism for shifting a print head in a column direction and moving the same in a line direction;

Fig. 3 is a diagram showing shift positions for print heads;

Fig. 4 is a diagram illustrative of printing procedures for various print formats;

Fig. 5 is an exploded perspective view of a shift mechanism;

Figs. 6 and 7 are side elevational views showing unshifted and shifted positions of the print head;

Figs. 8 and 9 are side elevational and plan views of a carriage drive mechanism;

Fig. 10 is an exploded perspective view of the carriage drive mechanism;

Fig. 11 is a perspective view of a modification of the first embodiment of the present invention;

Fig. 12 is a diagram showing different print format examples;

Fig. 13 is a perspective view of a multihead serial printer according to a second embodiment of the present invention; and

Fig. 14 is an enlarged exploded perspective view of a vertical shift mechanism for a pen head in the multihead serial printer illustrated in Fig. 13.

Detailed description of the preferred embodiments

The present invention for attaining the above-mentioned objects will now be described in detail with reference to embodiments illustrated in the accompanying drawings.

According to a first embodiment of the invention, the print heads can be shifted in a paper-feeding direction across the platen.

Fig. 1 illustrates in perspective a multihead serial printer according to the first embodiment. Designated as 101 is a sheet of print paper, 102 a platen, 103a and 103b print heads, 104 an ink ribbon cartridge, 105a and 105b shift mechanisms for vertically moving the print heads 103a and 103b along the surface of the platen 102, 106 and 107 guide shafts, and 108 a rack. The print heads 103a, 103b are arranged in a character-spacing direction, and can be independently shifted in a paper-feeding, or line-spacing, or column direction and moved in the character-spacing or line direction.

Fig. 2 fragmentarily shows a mechanism for shifting the print head 103a in the column direction and moving the same in the line direction. The mechanism includes a shifting motor 109a for actuating the shift mechanism 105a to shift the print head 103a in the column direction, and a flat DC brushless motor 110a having a gear meshing with the rack 108, the motor 110a being attached to a carriage 111a. The carriage 111a is supported on the guide shafts 106, 107 for movement in the character-spacing direction.

Operation of the multihead serial printer according to the first embodiment is as follows: When the flat DC brushless motor 110a is rotated, the carriage 111a is moved under a reactive force since a pinion mounted on a rotatable shaft of the motor is held in mesh with the rack 108. As the carriage 111a is guided and supported by the guide shafts 106, 107, the carriage 111a moves in a character-spacing or line direction. As the shifting motor 109a is rotated, the print head 108a is caused by the shift mechanism 105a to move in a paper-feeding or column direction along the surface of the platen 102. The print head 103a can thus be shifted in the column direction and moved in the line direction. When print wires are projected while the print head 103a is moved in the line direction, ink is transferred thereby from an ink ribbon of the ink ribbon cartridge 104 to form dots on the sheet 101.

Although the above operation has been described as being related to the print head 103a, the print head 103b can also be shifted in the column direction and moved in the line direction in the same manner as described above. Since the print heads 103a, 103b are shifted and moved by the separate motors, they can be controlled independently of each other. This advantage will be described with reference to Figs. 3 and 4.

Fig. 3 shows various shifted positions of the print heads 103a, 103b. Fig. 3(a) illustrates a position in which the print heads are horizontally aligned for printing one line. Fig. 3(b) shows a position in which one of the print heads is shifted for printing two lines. Fig. 3(c) is illustrative of a position in which one of the print heads is shifted by a pitch of 1/2 dot for high-density printing.

Printing procedures for various print formats will be described with reference to Fig. 4.

(1) When a print area spreads all over the sheet of print paper (see a data list shown in Fig. 12(a)): The print heads 103a, 103b are positioned in the one-line printing position illustrated in Fig. 3(a), and moved in the character-spacing directions indicated by the arrows from the positions (1) and (2) in Fig. 4(a).

(2) When a print area lies on one side or is localized on the sheet (see a program list in Fig. 12(b)): The print heads 103a, 103b are positioned in the two-line printing position illustrated in Fig. 3(b), and moved in the character-spacing directions indicated by the arrows from the positions (1) and (2) in Fig. 4(b).

The printing operation may be effected as shown in Fig. 4(c), employing movements similar to those in Fig. 4(a). However, the printing procedure of Fig. 4(b) is better inasmuch as two line feed operations for one line spacing are faster than one line feed operation for two line spacings.

(3) When print areas are divided on both sides of the sheet (see an account book sheet in Fig. 4(c)): The print heads 103a, 103b are positioned in the one-line printing position illustrated in Fig. 3(a), and moved in the character-spacing directions indicated by the arrows from the positions (1) and (2) in Fig. 4(d). Line feed is effected when both print heads complete one line printing, and the print head which has completed one line printing faster than the other is shifted to a print position for a next line and waits for the other print heat to complete its printing.

(4) When print areas are dispersed on one line or in the column direction (see a deposit item change table in Fig. 12(d)): The print heads 103a, 103b are positioned in the one-line printing position illustrated in Fig. 3(a), and moved in the character-spacing directions indicated by the arrows from the positions (1) and (2) in Fig. 4(d) for shortest printing intervals.

(5) For high-density printing:

The print heads 103a, 103b are positioned in the high-density printing position illustrated in Fig. 3(c), and moved in the character-spacing directions indicated by the arrows from the mutually close positions (1) and (2) in Fig. 4(e) for printing. At this time, each print head is shifted in the column direction for an interval obtained by dividing one dot pitch of the print head by the number of print heads used (in the illustrated example, two print heads are employed, and they are shifted by 112 dot pitches).

Fig. 5 is a perspective view of the shift mechanism which has side frames 112a, 113a and the shifting motor 109a, which are mounted on the carriage 111a. The side frames 112a, 113a have in their inner surfaces grooves 114a, 115b defined respectively therein and having a center of curvature equal to the center of the platen. A guide 116a has ridges 117a, 118a fitted respectively in the grooves 114a, 115a so that the guide 116a can be angularly moved along the surface of the platen. The guide 116a also has a substantially inverted U-shaped cam follower surface 119a in its central lower portion, and an eccentric cam

120a mounted on the rotatable shaft of the shifting motor 109a is held in contact with the cam follower surface 119a. The print head 103a is fixed to the guide 116a and sandwiched between the side frames 112a, 112b. The guide 116a is normally urged downwardly by a reset spring 121a.

In operation, when the eccentric cam 120a is rotated in response to rotation of the shifting motor 109a, the guide 116a contacting the cam 120a through the cam follower surface 119a is moved up and down. As the ridges 117a, 118a of the guide 116a are fitted in the grooves 114a, 115a in the side frames 112a, 113a, the guide 116a and the print head 103a are angularly moved along the surface of the platen. Therefore, the distance between the platen 102 and the print head 103a remains constant irrespective of the interval of shifting movement of the print head 103a. Fig. 6 shows the print head 103a in an unshifted position, and Fig. 7 illustrates the print head 103a in a shifted position.

Figs. 8 and 9 show a carriage drive mechanism. The flat DC brushless motor 110a is disposed below the carriage 111a and has a shaft on which there is mounted a pinion 122a held in mesh with the rack 108.

Fig. 10 illustrates the carriage drive mechanism in greater detail. The rotational angle of the flat DC brushless motor 110a is detected by a photosensor 123a. The rack 108 is fixed to a lower frame 124a. The print head 103a, the shifting motor 109a, the flat DC brushless motor 110a and the photosensor 123a, all mounted on the carriage 111a, are electrically connected to a control circuit, not shown, by a flexible cable 125a.

The carriage drive mechanism operates by rotating the flat DC brushless motor 110a with electric power supplied through the flexible cable 125a, thus rotating the pinion 122a. Upon rotation of the pinion 122a, the photosensor 123a issues a signal indicative of an angle of rotation of the motor 110a, and the carriage 111a is moved under a reactive force from the rack 108.

The shift mechanism shown in Figs. 5, 6, and 7, and the carriage drive mechanism illustrated in Figs. 8, 9, and 10 have been described as being associated with the print head 103a. The print head 103b is also associated with the same mechanisms.

The present invention is not limited to the above embodiment, but many changes and modifications may be made therein. For example, two ink ribbon cartridges 104a, 104b may be used as shown in Fig. 11 in place of the ink ribbon cartridge 104, and may be mounted on carriages 111a, 111b, respectively. In this modification, a righthand arm of the ink ribbon cartridge 104a and a lefthand arm of the ink ribbon cartridge 104b should be as thin as possible to position the print heads 103a, 103b closely together. This reduces distances which the print heads have to move in approaching the print-start positions in the print formats shown in Figs. 4(b) and (e). Although the self-propelled carriage drive mechanism with the drive motor mounted on the carriage is simpler in construction, the drive motor may be mounted on the frame, and the carriage may be moved by the drive motor through a belt or a wire.

Where the platen is of a flat shape rather than a cylindrical shape, the print head may be moved perpendicularly to the carriage. With this alternative, the grooves 114a, 115a and the ridges 116a, 117a are straight in configuration.

According to the first embodiment, as described above, since the plurality of print heads is arranged in the character-spacing direction, a space required therefor may be of substantially the same dimensions as those for the space for a single head, and the pair of guide shafts is sufficient. In the high-density printing, the print heads are only shifted in the paper-feeding direction, and there is no paper feeding operation which would feed the sheet in an unstable interval. Therefore, any positional error is small to maintain good printing quality.

According to a second embodiment of the present invention, at least one of print heads comprises a pen head.

Fig. 13 illustrates in perspective a multihead serial printer according to the second embodiment of the present invention. Designated as 201 is a sheet of print paper, 202 a platen around which the sheet 201 is wound to provide a print surface, and 203a, 203b guide shafts extending parallel to the platen 202, the platen 202 and the guide shafts 203a, 203b being supported at their ends by frames. Denoted as 204, 205 are carriages slidably mounted on the guide shafts 203a, 203b, 206 an ordinary print head mounted on the carriage 204 and having dot-matrix wires, 207 an ink ribbon cartridge mounted on the carriage 204, 208 a pen head mounted on the carriage 205 and having a plurality of pens, 209 a vertical shift mechanism (described later) for moving the pen head 208 in a direction in which the sheet 201 is fed, i.e., in the column direction, and 210 a rack held in mesh with pinions on spacing motors mounted respectively on the carriages 204, 205. The carriages 204, 205 can therefore be selectively moved independently or together in the character-spacing direction.

The vertical shift mechanism 209 for the pen head 208 will be described.

Fig. 14 is an enlarged exploded perspective view of the vertical shift mechanism 209. The pens are designated as 211 and may comprise ball-point pens or ink pens. The pens 211 are horizontally supported by guides 212 so as to be directed toward the platen 202. The guides 212 are sandwiched by and between guides 213 having grooves 214a, 214b, having a center of curvature equal to the center of the platen 202. The guides 212 are fitted endwise in the grooves 214a, 214b for sliding movement therein. With the guides 212 thus slidably moved, the tip ends of the pens 211 can be moved along the surface of the platen 202 in the paper-feeding or column direction for a desired interval.

Designated as 215 is a cam follower supporting thereon the guides 212 and urged by a reset spring 216 toward the carriage 205. An eccentric cam 217 is disposed in the cam follower 215 and rotatable by a drive motor 218. When the eccentric cam 217 is rotated by the drive motor 218, the cam follower 215 is moved up and down.

An actuator 219 has one end engaging in slots 211a in the pens 211 and is magnetically attracted by a magnet 220. The actuator 219 is moved under magnetic attraction of the magnet 220 to press the pens 211 toward the platen 202.

The vertical shift mechanism 209 is thus constructed, and its operation will not be described as it is the same as the operation of the first embodiment described with reference to Figs. 6 and 7.

With the second embodiment, only one print head is supported on each carriage, and hence can be moved at a high speed. Characters are printed by the dot-matrix print head at a high speed, while graphic patterns are plotted as smooth lines by the pen head. As a consequence, the printing speed is increased, and the printing quality is improved.

**Claims**

1. A multihead serial printer having a plurality of print heads (103a, 103b, 206) arranged along the character-spacing or horizontal direction of a platen (102, 202), said print heads (103a, 103b, 206) being mounted respectively on a plurality of movable carriages (111a, 111b, 204, 205) and a plurality of motors (109a, 218) being operatively coupled with said carriages (111a, 111b, 204, 205) respectively, for independently moving said carriages, said motors (109a, 218) being mounted on said carriages respectively, for enabling said carriages to be self-propelled, characterized in that a shift mechanism (105a, 105b, 209) is mounted on at least one of said carriages (111a, 111b, 204, 205) and said plurality of motors (109a, 218) is operatively coupled with said shift mechanism (105a, 105b, 209) respectively, for independently moving said print heads (103a, 103b, 206) in a paper-feeding or vertical direction along the surface of the platen (102, 202).

2. A multihead serial printer according to claim 1, characterized in that at least one of said print heads (206) comprises a pen head (208).

3. A multihead serial printer according to claim 2, characterized in that the pen head (208) comprises a plurality of pens (211), being arranged along the horizontal direction of the platen (202) and being supported by a guide means (212).

**Patentansprüche**

1. Seriendrucker mit mehreren Schreibköpfen (103a, 103b, 206), welche entlang der Richtung der untereinander beabstandeten Zeichen bzw. der horizontalen Richtung einer Gegendruckwalze (102, 202) angeordnet sind, wobei die Schreibköpfe (103a, 103b, 206) jeweils auf einem bewegbaren Wagen (111a, 111b, 204, 205) befestigt sind und eine Mehrzahl von Motoren (109a, 218) mit den Wagen (111a, 111b, 204, 205) operativ gekoppelt sind, um die Wagen unabhängig voneinander zu bewegen, wobei die Motoren (109a, 218) auf den Wagen befestigt sind, so daß die Wagen selbst-angetrieben sind, dadurch gekennzeichnet, daß ein Verstellmechanismus (105a, 105b, 209) auf zumindest einem der Wagen (111a, 111b, 204, 205) befestigt ist und die Mehrzahl der Motoren (109a, 218) mit dem Verstellmechanismus (105a, 105b, 209) jeweils operativ gekoppelt sind, um die Schreibköpfe (103a, 103b, 206) in einer Papierzuführungs-oder vertikalen Richtung entlang der Oberfläche der Gegendruckwalze (102, 202) unabhängig zu bewegen.

2. Seriendrucker mit mehreren Schreibköpfen nach Anspruch 1, dadurch gekennzeichnet, daß zumindest einer der Schreibköpfe (206) einen Stiftkopf (208) umfaßt.

3. Seriendrucker mit mehreren Schreibköpfen nach Anspruch 2, dadurch gekennzeichnet, daß der Stiftkopf (208) eine Mehrzahl von Stiften (211) umfaßt, die entlang der horizontalen Richtung der Gegendruckwalze (202) angeordnet sind und von einer Führungseinrichtung (212) getragen sind.

**Revendications**

1. Imprimante en série à têtes multiples comportant plusieurs têtes (103a, 103b, 206) d'impression disposées le long de la direction horizontale ou d'espacement des caractères d'un cylindre (102, 202), lesdites têtes d'impression (103a, 103b, 206) étant montées respectivement sur plusieurs chariots mobiles (111a, 111b, 204, 205) et plusieurs moteurs (109a, 218), étant accouplés fonctionnellement auxdits chariots (111a, 111b, 204, 205), respectivement, pour déplacer de façon indépendante lesdits charoits, lesdits moteurs (109a, 218) étant montés sur lesdits chariots, respectivement, pour permettre auxdits chariots d'être autopropulsés, caractérisée en ce que un mécanisme de décalage (105a, 105b, 209) est monté sur au moins l'un desdits chariots (111a, 111b, 204, 205) et ladite pluralité de moteurs (109a, 218) est accouplée fonctionnellement audit mécanisme de décalage (105a, 105b, 209), respectivement, pour déplacer de façon indépendante lesdites têtes d'impression (103a, 103b, 206) dans une direction verticale ou d'avance du papier le long de la surface du cylindre (102, 202).

2. Imprimante en série à têtes multiples selon la revendication 1, caractérisée en ce que au moins l'une desdites têtes d'impression (206) comprend une tête à crayons (208).

3. Imprimante en série à têtes multiples selon la revendication 2, caractérisée en ce que la tête à crayons (208) comprend plusieurs crayons (211) agencés le long de la direction horizontale du cylindre (202) et supportés par un moyen de guidage (212).

Fig. 1

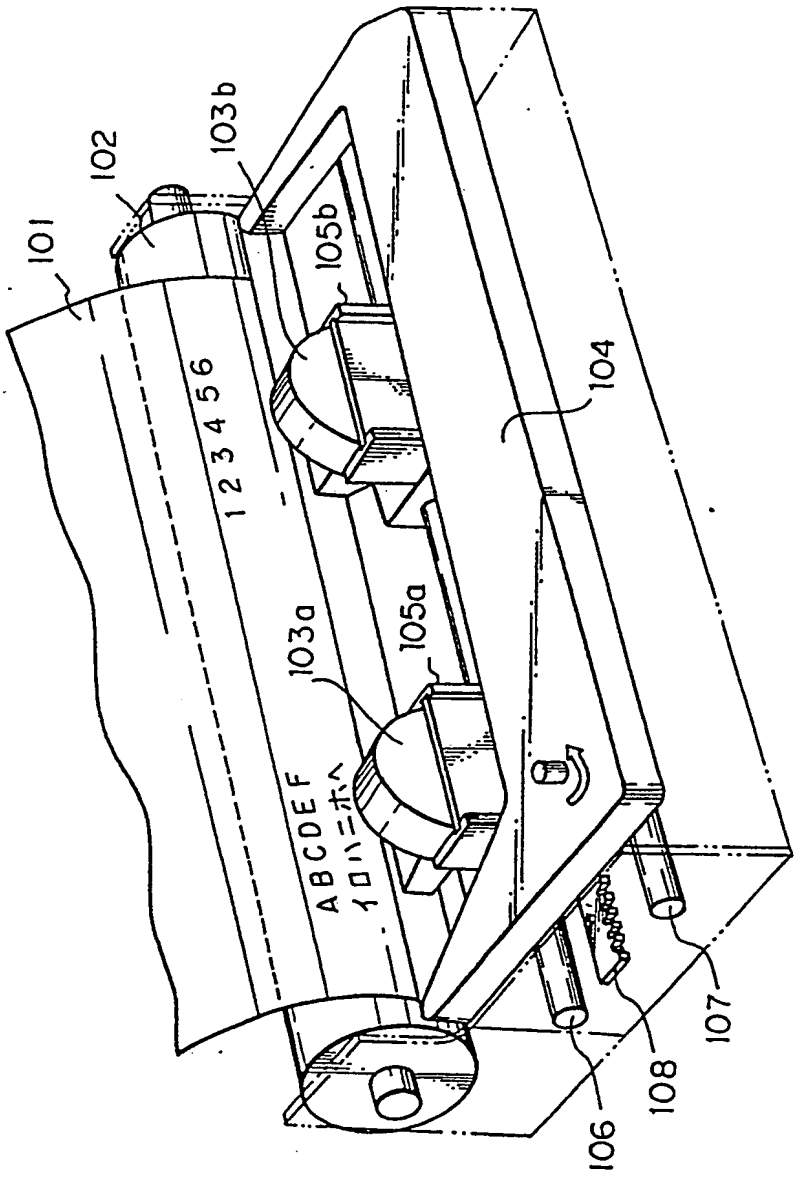


Fig. 2

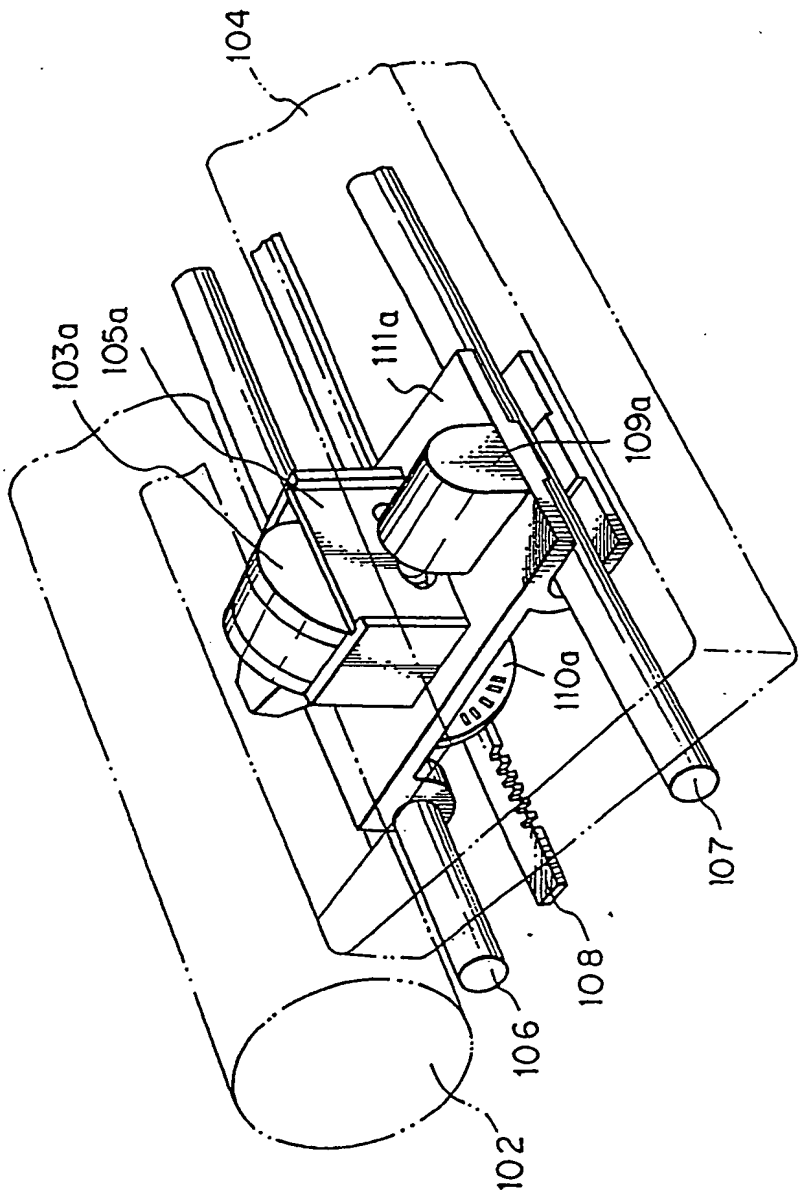


Fig. 3

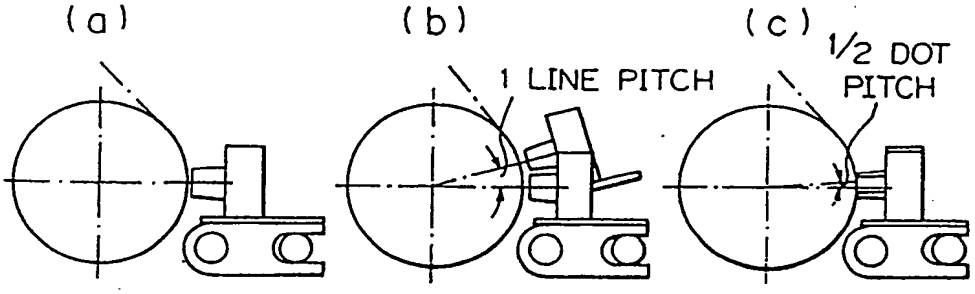



Fig. 4

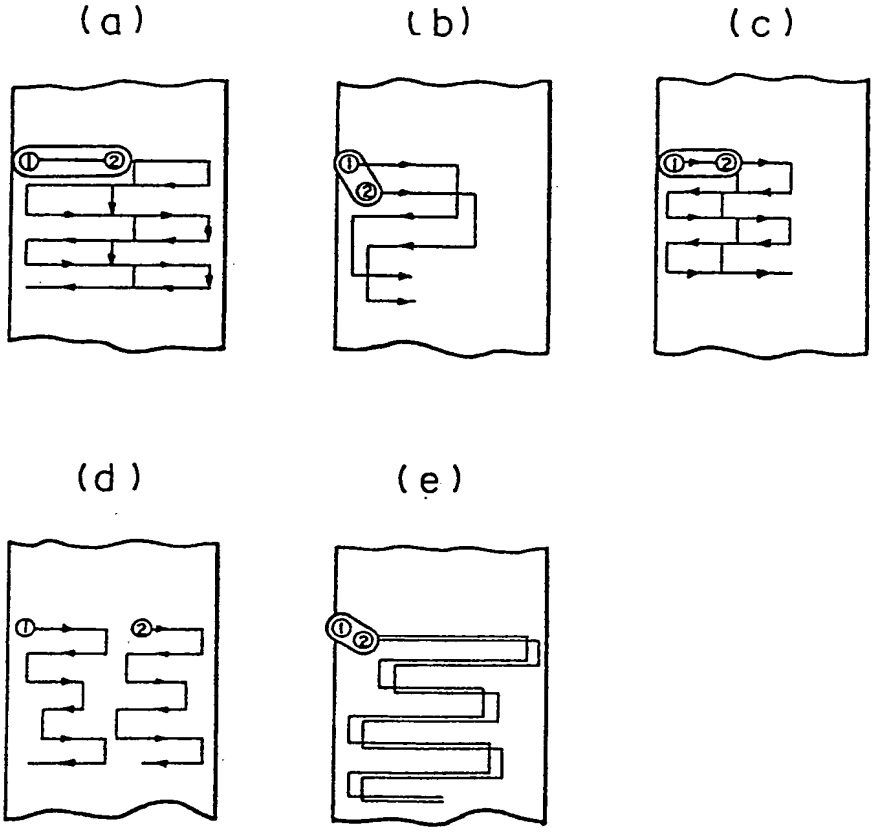


Fig. 5

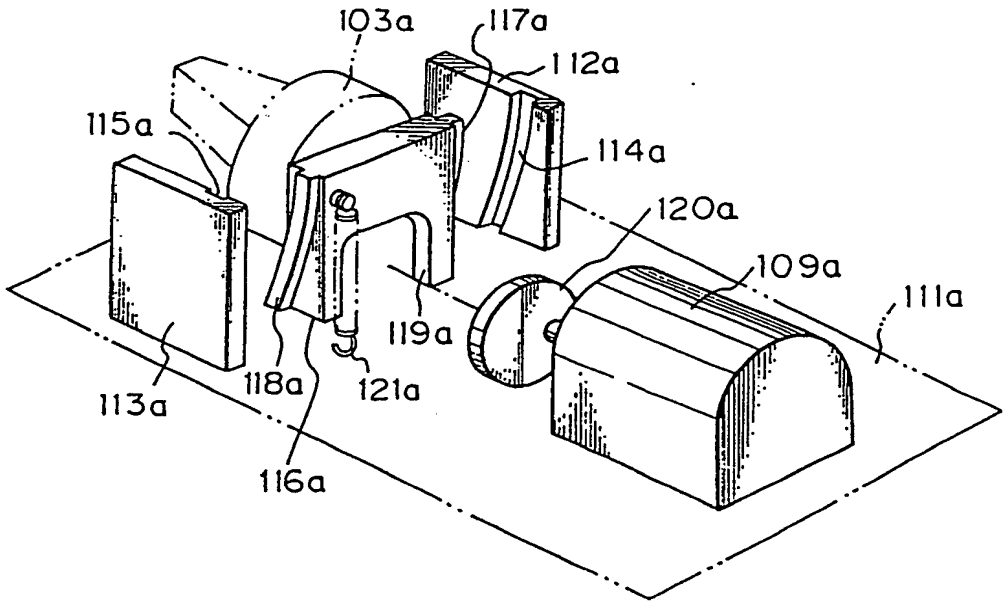



Fig. 6

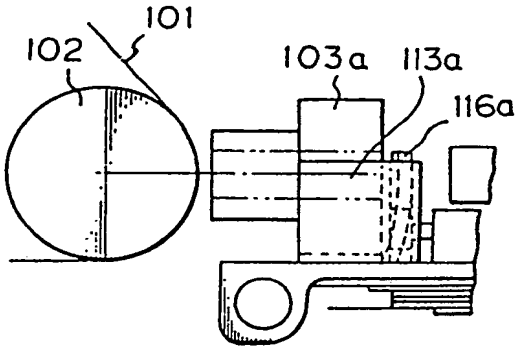



Fig. 7

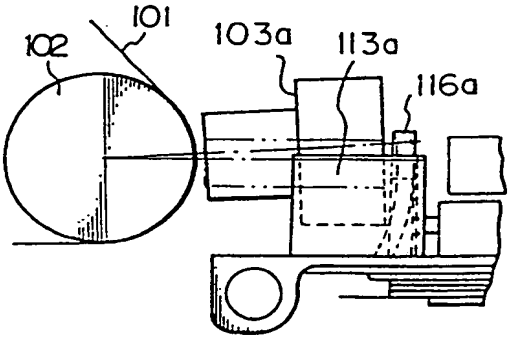


Fig. 8

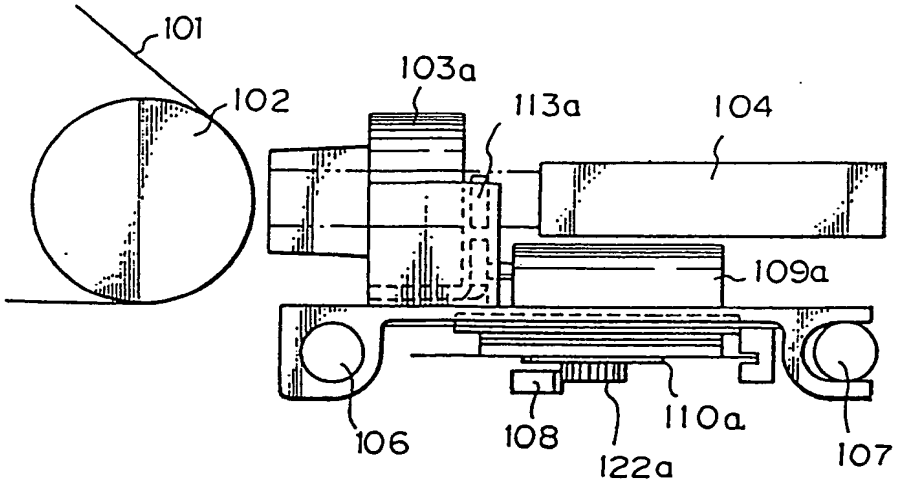

101
102
103a
113a
104
109a
106
108
122a
110a
107

Fig. 9

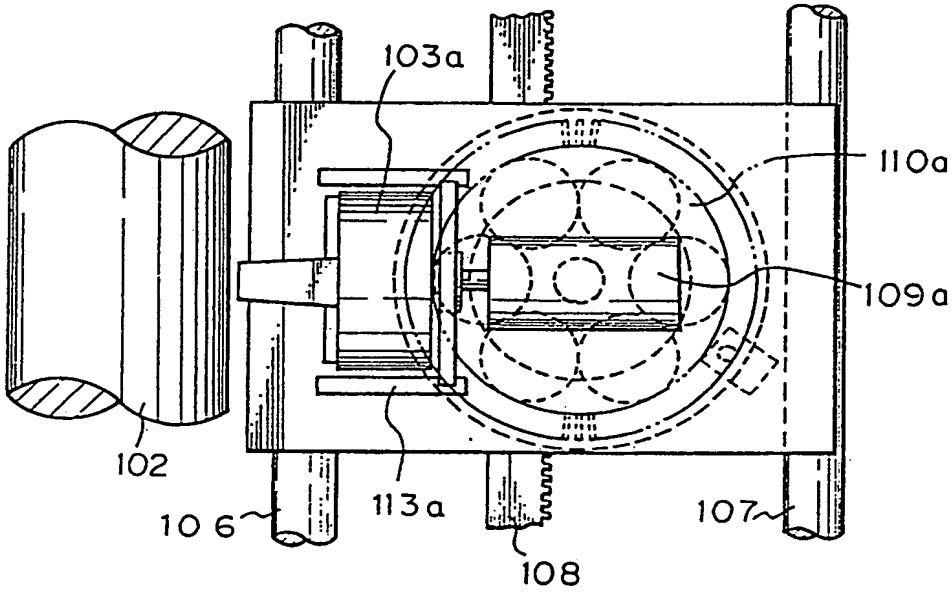

103a
110a
109a
102
106
113a
108
107

Fig. 10

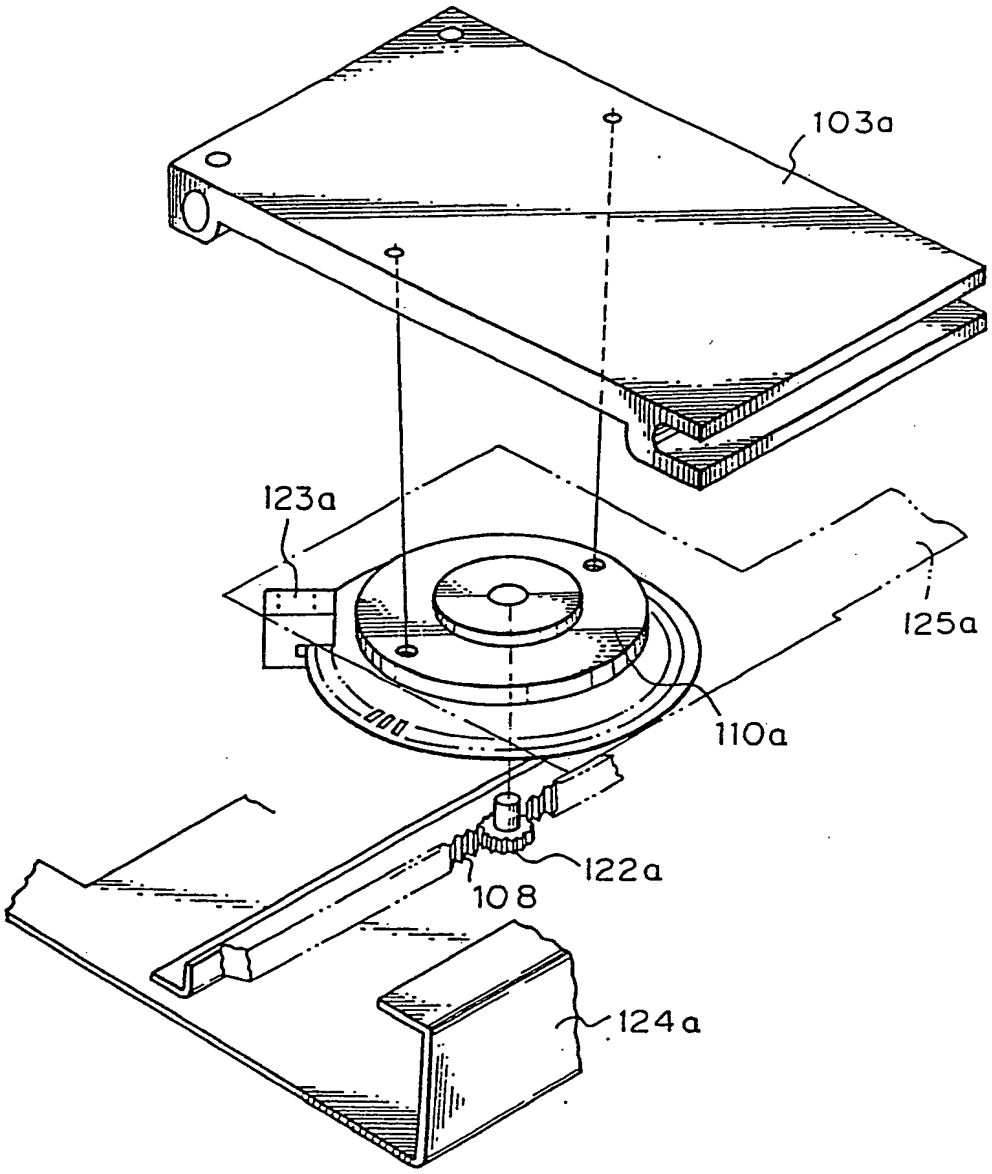


Fig. 11

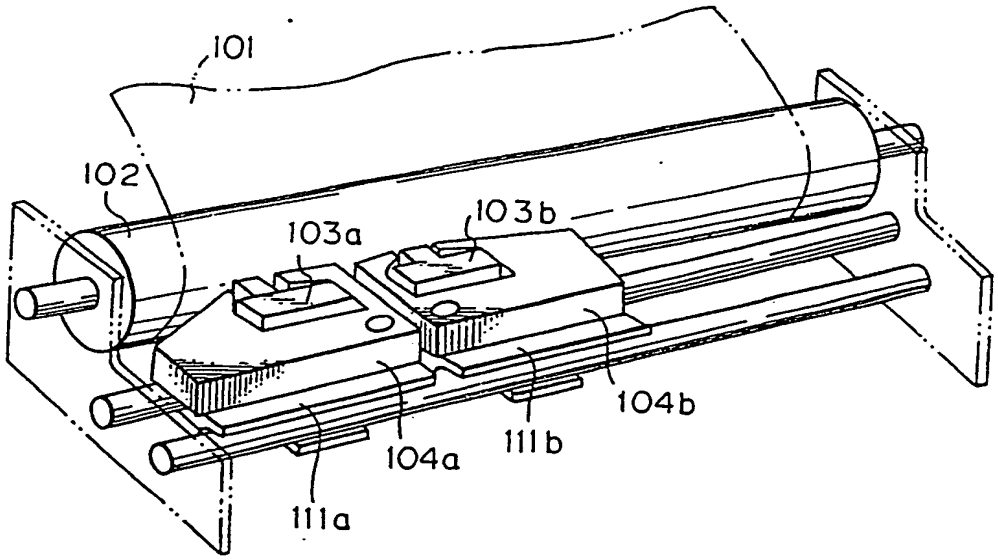

101
102
103a
103b
104b
104a
111b
111a

Fig. 13

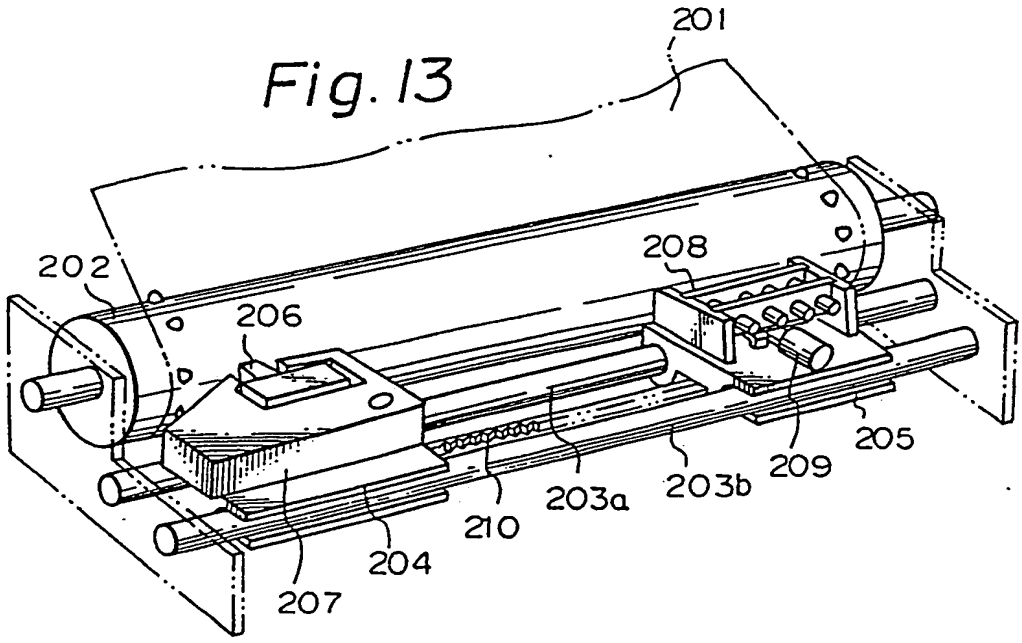

201
202
206
208
205
209
203b
203a
210
204
207

Fig. 12

(a)

```
 810103 BLUE  STEREO SYSTEM 96755
 801216 BLUE  COLOR TV      84361
 810203 YELLOW TOASTER      71344
```

(b)

```
1000 REM  ADD
1010 A=0: B=0: C=0
1020 INPUT A
1030 INPUT B
1040 C=A+B
```

(c)

| PAYMENT | | ITEM | RECEIPT | |
|---|---|---|---|---|
| NO. | SUM | | NO. | SUM |
| | | CASH | | |
| | | TRANSFER | | |
| | | - - - - | | |
| | | - - - - | | |

(d)

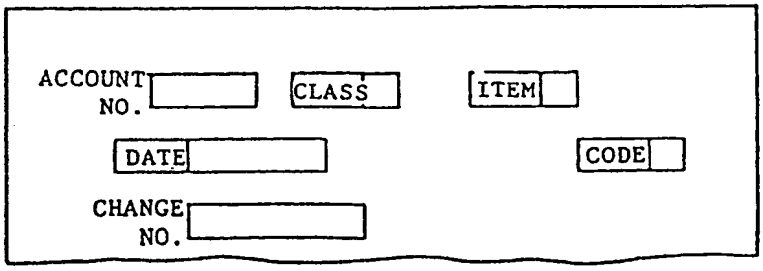
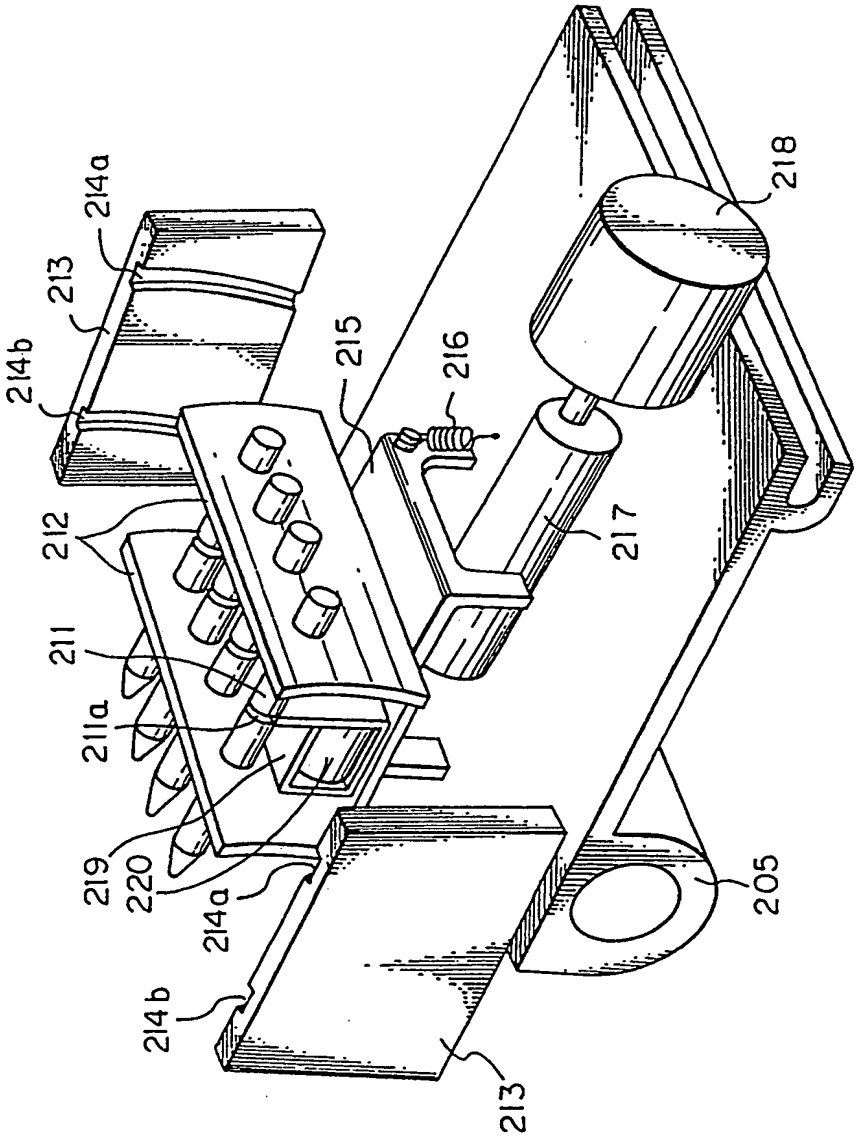


Fig. 14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